FINAL
FIELD SAMPLING PLAN FOR
AREAS 6, 7, and 8

OF THE
CAMP EDWARDS IMPACT AREA
GROUNDWATER QUALITY STUDY

MASSACHUSETTS MILITARY RESERVATION
CAPE COD, MASSACHUSETTS

Prepared for

NATIONAL GUARD BUREAU
ARLINGTON, VIRGINIA

Prepared by

OGDEN ENVIRONMENTAL AND ENERGY SERVICES
239 Littleton Road, Suite 1B
Westford, Massachusetts 01886

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DISCLAIMER:

This document has been prepared pursuant to a government administrative order (U.S. EPA Region I SDWA Docket No. I-97-1019) and is subject to approval by the U.S. Environmental Protection Agency. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency.

A.5 Areas 6, 7, and 8 Field Sampling Plan

A.5.1 Background and Focal Area(s)

Areas 6, 7, and 8 are burn areas located within the Impact Area. The majority of the surface area within the Impact Area has been burned at one time or another, during controlled burns or from wildfires resulting from training or natural causes. These three areas were identified for sampling in discussions with EPA and MADEP, and are suspected to be representative of other burn areas within the Impact Area. The three areas do not include any known target areas or waste management activities. The affects of a fire across each area are expected to be relatively homogeneous, in that any UXO that are damaged or detonated would be scattered at random in the area.

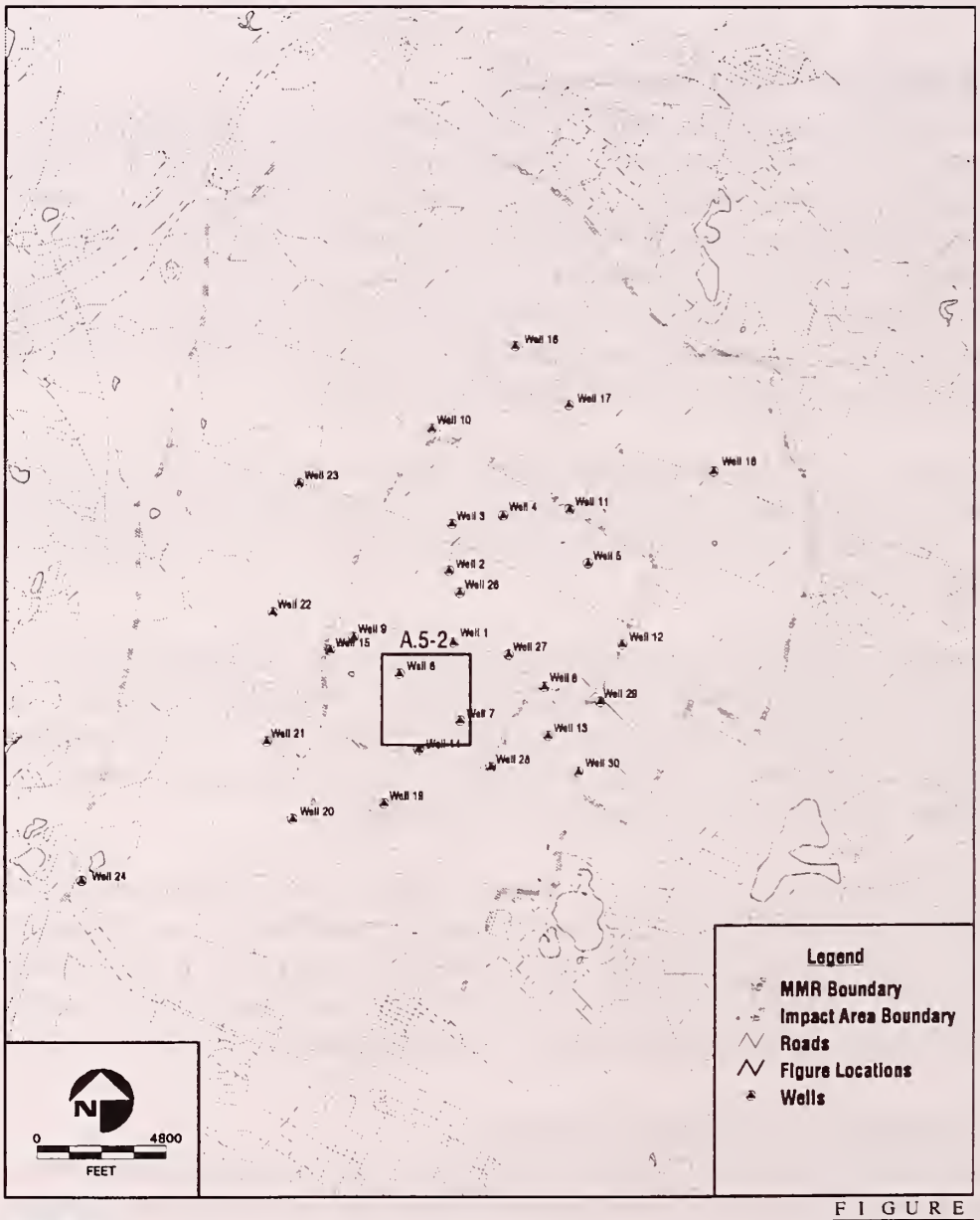
Area 6 is one burn area that is apparent in aerial photographs from 1958. The area lies southeast of the intersection of Turpentine Road and Tank Alley as illustrated in Figure A.5-1. It consists of one focal area as illustrated in Figure A.5-2. The estimated size of this area is 5 acres.

Area 7 consists of three burn areas that are apparent in aerial photographs from 1958. The area lies southwest of the intersection of Turpentine Road and Tank Alley. The three burn areas are considered one focal area as illustrated in Figure A.5-3. The estimated size of these areas is approximately 8 acres. The access road to Area 7 is a control area for soil sampling as discussed in a separate field sampling plan.

Area 8 is a burn area which is apparent in aerial photographs from 1958. Succonessett Pond lies near the center of the burn area. The perimeter of the pond, which has been cleared of UXO, will serve as a representative focal area of the burn area as illustrated in Figure A.5-3. Succonessett Pond will also have surface water and sediment samples, as described in a separate field sampling plan. The estimated size of Area 8 is 170 acres.

A.5.2 Sampling & Analysis Methods

Areas 6, 7 and 8 sampling will include surface soil at each focal area based on the potential release of munitions-related contaminants at ground surface from burning activities. All surface soil samples will be collected at locations which are undisturbed by excavation or road building activities. Areas 6 and 7 sampling will include subsurface



FIGURE

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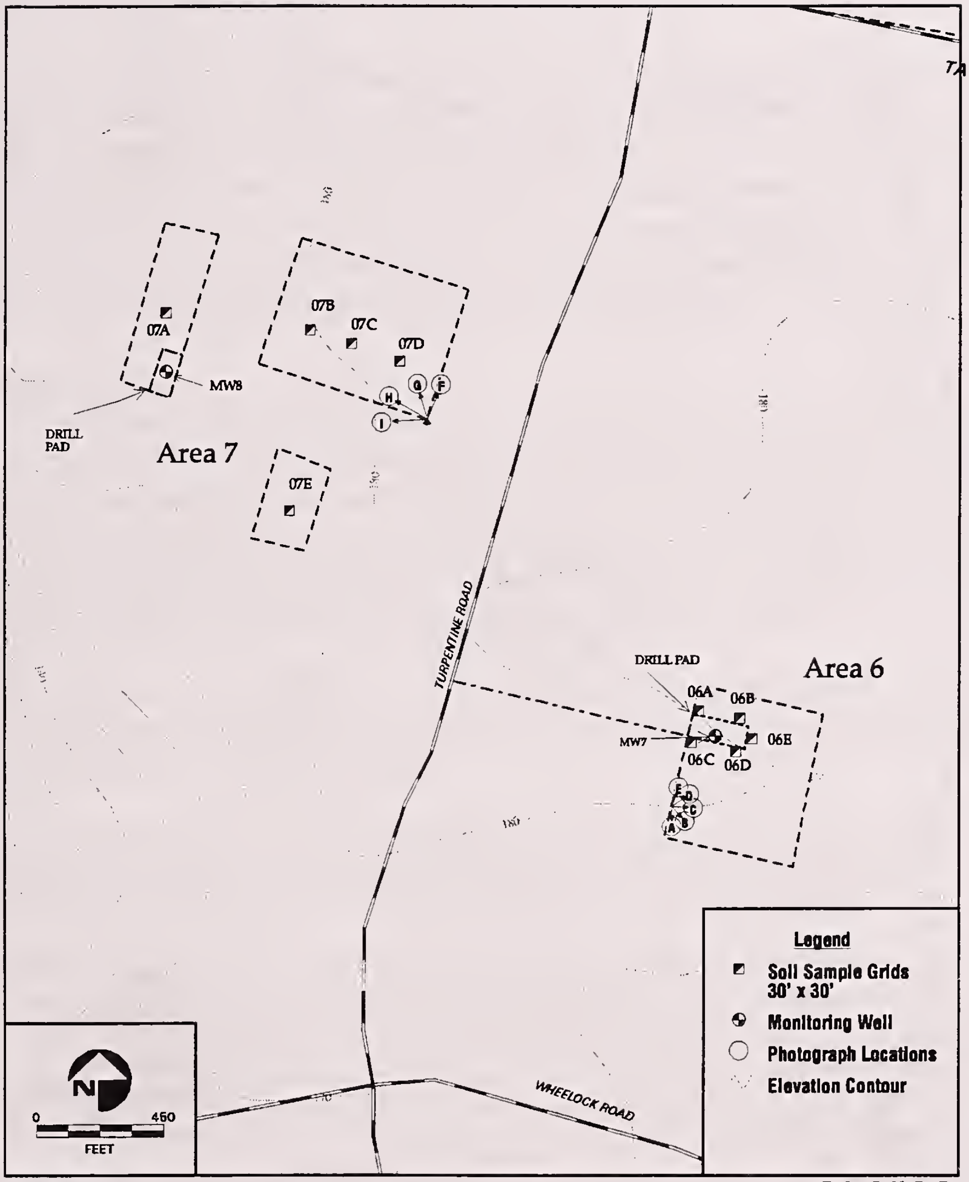
MMR - Areas 6 and 7 Vicinity Map

A.5-1



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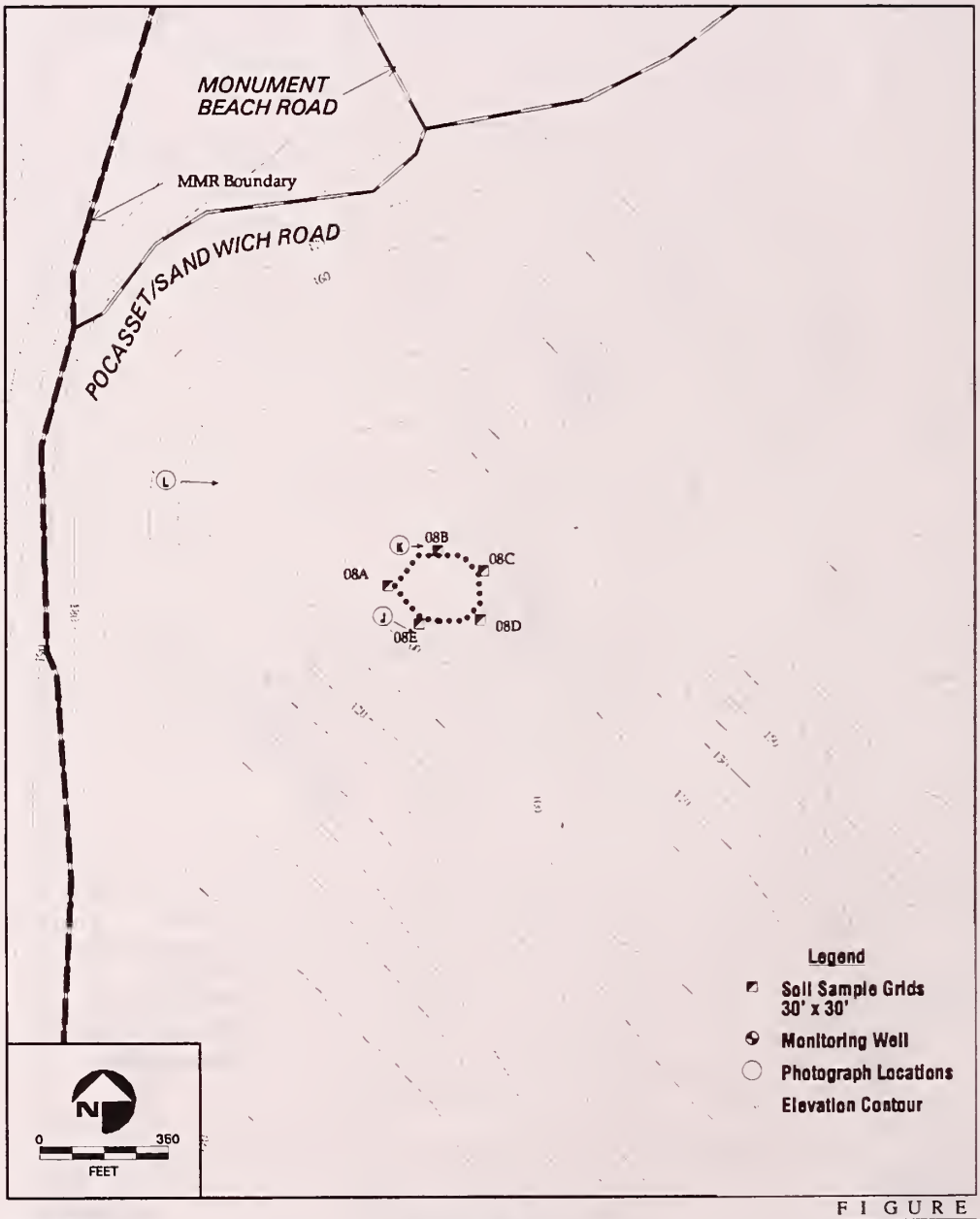
Focal Area(s) within Area 6 and Area 7

FIGURE A.5-2



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Area 8
Succonesset Pond
Sampling Points

FIGURE
A.5-3

soil and groundwater based on the potential for contaminants to migrate into deeper soils or groundwater.

Sample collection will be consistent with MMR SOPs, the Ogden Health and Safety Guidelines, Attachment A: Field guide to High Explosives, and the EPA Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities (October 31, 1996). Areas 6, 7 and 8 are within the Impact Area and buffer zone, therefore all samples with detectable levels of explosives by the colorimetric analysis will be analyzed by EPA Method 8330. **All borings and hand auger locations in Areas 6, 7 and 8 are subject to UXO clearance requirements.**

Hand Auger Grids

Areas 6, 7, and 8 are located in burn areas. Any possible contaminants in these areas are expected to be distributed homogeneously throughout the entire burn area. There is no information to suggest that these areas differ from each other, or that there are differences within a given area. Therefore, five grids will be investigated per focal area, in order to characterize a representative portion of the area. In each focal area, the five grids will be located where UXO clearance and road building make access practical.

A portion of each focal area which represents conditions throughout the burn will be sampled, as indicated in Figure A.5-2 and A.5-3. Following is the distribution of soil sampling grids in each of the focal areas:

- Five grids (06A-06E) will be placed in a 1-acre portion of burn area 6 which is accessible and cleared of UXO because it surrounds the drill pad at MW7.

- Five grids (07A-07E) will be placed in burn area 7, which consists of three separate burn areas. Three soil sampling grids will be placed in a line running from east to west in the largest of the three burn areas. One will be placed near the center of each of the other two burn areas in order to provide the highest probability of encountering the burn areas for which there are currently no visible surface features.

- Five grids (08A-08E) will be placed around the perimeter of Succonessett Pond in the burn area. This area is accessible because it has already been cleared for UXO for surface water and sediment sampling.

Each soil boring grid will consist of nine sample points spaced ten feet apart as illustrated

in Figure A.5-4. The following protocol will be followed for hand augering:

1. A 0-6" soil sample will be collected from each of the nine sample points in a grid;
2. soil from each sample point will be placed in a headspace jar;
3. the remaining soil from each of the nine sample points will be composited in accordance with Section 8.1 of the EPA Standard Guide and Attachment A of this FSP;
4. headspace measurements will be collected from each of the nine 0-6" samples and recorded in the space provided on the hand auger log;
5. a VOC grab sample will be collected from one sample point based on the following priority of observations: 1)highest response on the FID, 2) visual signs of contamination, 3) the central grid location (a fresh soil sample will be collected adjacent to the sample point). The VOC sample will be collected from within one-foot of the full screening sample;
6. the 0-6" composite sample will be submitted for explosives, inorganics, and other analytes;
7. when the analytical results from the 0-6" sample are available, an 18-24" sample will be collected and composited as described above for explosives and inorganics. Any other analytes (except VOC) that are detected in the 0-6" sample will be analyzed;
8. an 18-24" sample will be selected for VOC analysis based on screening with an FID as described in steps 1-5 above.

Barber Rig Drilling

A boring will be advanced to bedrock within Area 6 indicated in Figure A.5-1, and completed as a nested shallow and deep monitoring well (MW-7). An intermediate depth well will be completed in an adjacent boring at a depth based on the VOC and explosives screening of groundwater for the initial boring. The borings will be placed at approximately the center of Area 6 located to the south east of the intersection of Turpentine Road and Tank Alley. Another boring will be advanced at the center of the downgradient (western most) burn area in Area 7 (MW-8) in order to determine if the burn areas have impacted groundwater. This boring will be completed as a shallow monitoring well. The decision on well depth will be made in consultation with EPA.

Prior to the onset of the investigation, the site will be intrusively cleared of UXO to a depth of two feet below grade. Additional clearance will occur from a depth of two feet to 10 feet below grade. Under this procedure, a down-hole magnetometer will be lowered

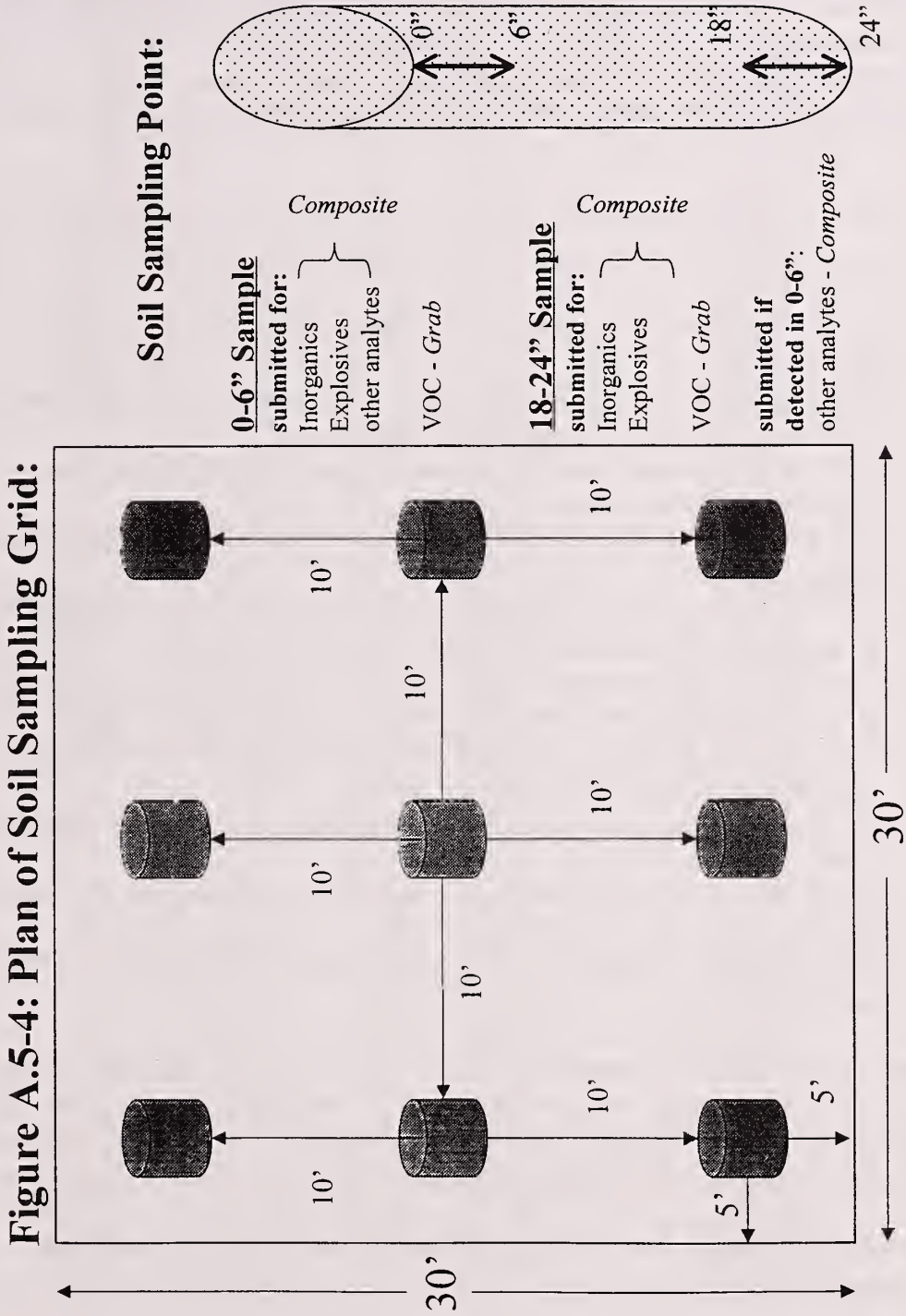
Figure A.5-4: Plan of Soil Sampling Grid:
Soil Sampling Point:
0-6" Sample
submitted for:
Inorganics
Explosives
other analytes
Composite
VOC - Grab
18-24" Sample
submitted for:
Inorganics
Explosives
Composite
VOC - Grab
submitted if
detected in 0-6":
other analytes - Composite
0"
6"
18"
24"
10'
5'
30'

into the hole prior to advancing the auger in two-foot intervals. After completion of the next two-foot interval, 4" PVC will be inserted into the borehole and the rig will be moved off of the hole prior to magnetic survey of the next interval. The boring location will be considered clear when a depth of ten feet is reached without encountering any magnetic anomalies (clearance to 12 feet).

The following activities will occur while drilling with the barber rig (every sample with explosives detected by the colorimetric method will also be analyzed by Method 8330):

1. A 0-6" sample will be collected and submitted for explosives, inorganics, and all other analytes;
2. From ten feet below grade until the water table is encountered, a soil sample will be collected every ten feet using a split spoon;
3. The 10-12' interval will be FID screened and submitted for explosives, inorganics, and other analytes;
4. The 20-22' interval will be FID screened and submitted for explosives, and inorganics;
5. Each sample below the 20-22' interval will be screened with an FID and sampled for explosives (submitted ON HOLD) and inorganic analysis;
6. The soil samples submitted ON HOLD for explosives will be analyzed only if explosives are detected in the 10-12' or 20-22' sample interval; and
7. Each sample at and below the 20-22' interval will be sampled for the other analytes only if there is a response on the FID.
8. An 18-24" sample will be collected for inorganics and explosives when the 0-6" sample results are received.
9. An 18-24" sample will be collected for any other analytes detected in the 0-6" sample.
10. The boring will be advanced 15 feet from refusal to confirm that bedrock has been encountered.

From the water table to the completion of the boring, soil will be sampled from the cyclone for lithology. Groundwater samples will be collected at every ten feet during advancement of the borings and will be submitted for laboratory analysis of explosives and VOCs. Wells will be screened as described in Section 4.2.2 of the Action Plan.

Table A.5-1 lists sample numbers and analytical requirements for the areas to be investigated.

Table A.5-1: MMR Soil Samples from Hand Auger Grids						Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Grid	Depth	Type	MMR ID	EPA/Ogden ID	Cont:	8oz	8oz	8oz		4 oz.	8 oz.			4 oz.*	
6	06A	0-6	grab	71BS06AXAX01XA	B06AAA						X					
			comp	71BS06AXAX01XA	B06AAA		X		X			X	X	X	X	X
		18-24	grab	71BS06AXBX01XA	B06ABA						#					
			comp	71BS06AXBX01XA	B06ABA		O		O			#	#	#	#	#
	06B	0-6	grab	71BS06BXAX01XA	B06BAA						X					
			comp	71BS06BXAX01XA	B06BAA		X		X			X	X	X	X	X
		18-24	grab	71BS06BXBX01XA	B06BBA						#					
			comp	71BS06BXBX01XA	B06BBA		O		O			#	#	#	#	#
	06C	0-6	grab	71BS06CXAX01XA	B06CAA						X					
			comp	71BS06CXAX01XA	B06CAA		X		X			X	X	X	X	X
		18-24	grab	71BS06CXBX01XA	B06CBA						#					
			comp	71BS06CXBX01XA	B06CBA		O		O			#	#	#	#	#
	06D	0-6	grab	71BS06DXAX01XA	B06DAA						X					
			comp	71BS06DXAX01XA	B06DAA		X		X			X	X	X	X	X
		18-24	grab	71BS06DXBX01XA	B06DBA						#					
			comp	71BS06DXBX01XA	B06DBA		O		O			#	#	#	#	#
	06E	0-6	grab	71BS06EXAX01XA	B06EAA						X					
			comp	71BS06EXAX01XA	B06EAA		X		X			X	X	X	X	X
		18-24	grab	71BS06EXBX01XA	B06EBA						#					
			comp	71BS06EXBX01XA	B06EBA		O		O			#	#	#	#	#
7	07A	0-6	grab	71BS07AXAX01XA	B07AAA						X					
			comp	71BS07AXAX01XA	B07AAA		X		X			X	X	X	X	X
		18-24	grab	71BS07AXBX01XA	B07ABA						#					
			comp	71BS07AXBX01XA	B07ABA		O		O			#	#	#	#	#
	07B	0-6	grab	71BS07BXAX01XA	B07BAA						X					
			comp	71BS07BXAX01XA	B07BAA		X		X			X	X	X	X	X
		18-24	grab	71BS07BXBX01XA	B07BBA						#					
			comp	71BS07BXBX01XA	B07BBA		O		O			#	#	#	#	#
	07C	0-6	grab	71BS07CXAX01XA	B07CAA						X					
			comp	71BS07CXAX01XA	B07CAA		X		X			X	X	X	X	X
		18-24	grab	71BS07CXBX01XA	B07CBA						#					
			comp	71BS07CXBX01XA	B07CBA		O		O			#	#	#	#	#
	07D	0-6	grab	71BS07DXAX01XA	B07DAA						X					
			comp	71BS07DXAX01XA	B07DAA		X		X			X	X	X	X	X
		18-24	grab	71BS07DXBX01XA	B07DBA						#					
			comp	71BS07DXBX01XA	B07DBA		O		O			#	#	#	#	#
	07E	0-6	grab	71BS07EXAX01XA	B07EAA						X					
			comp	71BS07EXAX01XA	B07EAA		X		X			X	X	X	X	X
		18-24	grab	71BS07EXBX01XA	B07EBA						#					
			comp	71BS07EXBX01XA	B07EBA		O		O			#	#	#	#	#

Table A.5-1: MMR Soil Samples from Hand Auger Grids						Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Grid	Depth	Type	MMR ID	EPA/Ogden ID	Cont:	8oz	8oz	8oz		4 oz.	8 oz.			4 oz.*	
8	08A	0-6	grab	71BS08AXAX01XA	B08AAA						X					
			comp	71BS08AXAX01XA	B08AAA		X		X			X	X	X	X	X
		18-24	grab	71BS08AXBX01XA	B08ABA						#					
			comp	71BS08AXBX01XA	B08ABA		O		O			#	#	#	#	#
	08B	0-6	grab	71BS08BXAX01XA	B08BAA						X					
			comp	71BS08BXAX01XA	B08BAA		X		X			X	X	X	X	X
		18-24	grab	71BS08BXBX01XA	B08BBA						#					
			comp	71BS08BXBX01XA	B08BBA		O		O			#	#	#	#	#
	08C	0-6	grab	71BS08CXAX01XA	B08CAA						X					
			comp	71BS08CXAX01XA	B08CAA		X		X			X	X	X	X	X
		18-24	grab	71BS08CXBX01XA	B08CBA						#					
			comp	71BS08CXBX01XA	B08CBA		O		O			#	#	#	#	#
	08D	0-6	grab	71BS08DXAX01XA	B08DAA						X					
			comp	71BS08DXAX01XA	B08DAA		X		X			X	X	X	X	X
		18-24	grab	71BS08DXBX01XA	B08DBA						#					
			comp	71BS08DXBX01XA	B08DBA		O		O			#	#	#	#	#
	08E	0-6	grab	71BS08EXAX01XA	B08EAA						X					
			comp	71BS08EXAX01XA	B08EAA		X		X			X	X	X	X	X
		18-24	grab	71BS08EXBX01XA	B08EBA						#					
			comp	71BS08EXBX01XA	B08EBA		O		O			#	#	#	#	#

X = to be collected and submitted to laboratory

= to be collected if detected in the 0-6" sample

O = to be collected after results from the 0-6" sample are received

Table A.5-1: MMR Subsurface Soil Samples from Borings					Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Loc.	Depth	MMR ID	EPA/Ogden ID	Cont.	8oz	8oz	8oz		4oz	8 oz.			4oz	
6	MW7	A(0-6")	71MS07DXAX01XA	S07DAA		X		X		X	X	X	X	X	X
		B(18-24")	71MS07DXBX01XA	S07DBA		@		@		@	@	@	@	@	@
		C(10-12')	71MS07DXCX01XA	S07DCA		X		X		X	X	X	X	X	X
		D(20-22')	71MS07DXDX01XA	S07DDA		X		X		*	*	*	*	*	*
		E	71MS07DXEX01XA	S07DEA		#		X		*	*	*	*	*	*
		F	71MS07DXFX01XA	S07DFA		#		X		*	*	*	*	*	*
		G	71MS07DXGX01XA	S07DGA		#		X		*	*	*	*	*	*
		H	71MS07DXHX01XA	S07DHA		#		X		*	*	*	*	*	*
		I	71MS07DXIX01XA	S07DIA		#		X		*	*	*	*	*	*
		J	71MS07DXJX01XA	S07DJA		#		X		*	*	*	*	*	*
		K	71MS07DXKX01XA	S07DKA		#		X		*	*	*	*	*	*
		L	71MS07DXLX01XA	S07DLA		#		X		*	*	*	*	*	*
		M	71MS07DXMX01XA	S07DMA		#		X		*	*	*	*	*	*
7	MW8	A(0-6")	71MS08DXAX01XA	S08DAA		X		X		X	X	X	X	X	X
		B(18-24")	71MS08DXBX01XA	S08DBA		@		@		@	@	@	@	@	@
		C(10-12')	71MS08DXCX01XA	S08DCA		X		X		X	X	X	X	X	X
		D(20-22')	71MS08DXDX01XA	S08DDA		X		X		*	*	*	*	*	*
		E	71MS08DXEX01XA	S08DEA		#		X		*	*	*	*	*	*
		F	71MS08DXFX01XA	S08DFA		#		X		*	*	*	*	*	*
		G	71MS08DXGX01XA	S08DGA		#		X		*	*	*	*	*	*
		H	71MS08DXHX01XA	S08DHA		#		X		*	*	*	*	*	*
		I	71MS08DXIX01XA	S08DIA		#		X		*	*	*	*	*	*
		J	71MS08DXJX01XA	S08DJA		#		X		*	*	*	*	*	*
		K	71MS08DXKX01XA	S08DKA		#		X		*	*	*	*	*	*
		L	71MS08DXLX01XA	S08DLA		#		X		*	*	*	*	*	*
		M	71MS08DXMX01XA	S08DMA		#		X		*	*	*	*	*	*

X - collect and submit

@ - to be collected after the results from the 0-6" sample are received

@ - to be collected if detected in the 0-6" sample

- collect and submit ON HOLD

* - collect and submitted only if there is an FID response.

Table A.5-1: MMR Groundwater Samples from Borings					Parameters:	Explosives (8330 screen)	Explosives (EPA 8330)	Inorganics:	Metals (filtered)	Cyanide	Phosphorous, Nitrate/Nitrite, Ammonia	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
			MMR	EPA/Ogden	Cont:	250mL	2*1L		500mL	1L	1L		3*40m	2*1L	2*1L	2*1L	3*40m	3*40m
Area	Loc.	Depth	ID	ID	Pres:	none	none		HNO3	NaOH	H2SO4		HCL	none	none	none	HCL	thioS
6	MW7	A	71GB07DXAX01XA	G07DAA		X							X					
		B	71GB07DXBX01XA	G07DBA		X							X					
		C	71GB07DXCX01XA	G07DCA		X							X					
		D	71GB07DXDX01XA	G07DDA		X							X					
		E	71GB07DXEX01XA	G07DEA		X							X					
		F	71GB07DXFX01XA	G07DFA		X							X					
		G	71GB07DXGX01XA	G07DGA		X							X					
		H	71GB07DXHX01XA	G07DHA		X							X					
		I	71GB07DXIX01XA	G07DIA		X							X					
		J	71GB07DXJX01XA	G07DJA		X							X					
		K	71GB07DXKX01XA	G07DKA		X							X					
		L	71GB07DXLX01XA	G07DLA		X							X					
		M	71GB07DXMX01XA	G07DMA		X							X					
		N	71GB07DXNX01XA	G07DNA		X							X					
		O	71GB07DXOX01XA	G07DOA		X							X					

Photograph A: Looking south from west side of Area 6.

Photograph B: Looking southeast from west side of area 6.

Photograph C: Looking east from west side of Area 6.

Photograph D: Looking northeast from west side of Area 6.

Photograph E: Looking north from west side of Area 6.

Photograph F: Looking northeast from east side of Area 7.

Photograph G: Looking north from east side of Area 7.

Photograph H: Looking northwest from east side of Area 7.

Photograph I: Looking west from east side of Area 7.

Photograph J: Looking southeast from southwest side of Succonsette Pond.

Photograph K: Looking east from north side of Succonsette Pond.

Photograph L: Looking east toward Succonsette Pond from path off Spruce Swamp Road.

ATTACHMENT A: FIELD GUIDE TO HIGH EXPLOSIVES

Any substance encountered during sampling activities which differs in any way from natural media will be treated as a dangerous substance, carefully removed from the sample, and set aside.

EXPLOSIVES

NAME	DESCRIPTION	REMARKS
BLACK POWDER	BROWN TO BLACK	MANUFACTURED IN GRAINS THAT RANGE IN SIZE FROM SMALLER THAN SALT GRAINS TO GRAINS AS LARGE AS SMALL PEBBLES. HIGHLY SENSITIVE TO IGNITION BY HEAT, FRICTION, FLAME, SPARK. WHEN WET, IT IS CORROSIVE TO MOST METALS.
TNT	LIGHT YELLOW TO BROWN OR GRAY	LIGHTLY CORROSIVE WITH LEAD. USED IN BOMBS, GRENADES, DEMOLITION CHARGES, PROJECTILES. EXUDES AT ELEVATED TEMPERATURES. MODERATELY TOXIC BY SKIN ABSORPTION OR INHALATION.
EXPLOSIVE D	BRIGHT YELLOW TO ORANGE. ALSO CALLED AMMONIUM PICRATE.	RELATIVELY INSENSITIVE. HIGHLY TOXIC BY INHALATION, INGESTION, OR SKIN ABSORPTION
AMATOL	LIGHT BROWN TO YELLOW/MIXTURE OF TNT AND EXPLOSIVE D	SLIGHT HYGROSCOPIC. HAS CORROSIVE EFFECTS ON COPPER, BRONZE, LEAD, BRASS. HIGHLY TOXIC BY INHALATION, SKIN CONTACT, INGESTION.
COMPOSITION B	WHITE TO BROWNISH YELLOW, MIXTURE OF TNT AND EXPLOSIVE D	SLIGHTLY CORRODES COPPER, BRASS, CADMIUM, ZINC. USED IN BOMBS, PROJECTILES, GRENADES, SHAPED CHARGES.
OCTOL	LIGHT BROWN	USED IN BOMBS, PROJECTILES, SHAPED CHARGES.
RDX	WHITE. ALSO CALLED CYCLONITE	SENSITIVE TO IMPACT AND FRICTION.SLIGHTLY CORROSIVE WITH COPPER, BRASS, MILD STEEL, CADMIUM. MODERATELY TOXIC BY INHALATION OR INGESTION.
HMX	WHITE. ALSO CALLED OCTOGEN	SENSITIVE TO IMPACT AND FRICTION. SLIGHTLY TOXIC.
PETN	WHITE	SENSITIVE TO IMPACT. SLIGHTLY CORROSIVE TO BRASS, CADMIUM, ZINC. VERY SLIGHTLY TOXIC.

EXPLOSIVES, continued

NAME	DESCRIPTION	REMARKS
LEAD AZIDE	WHITE TO LIGHT BROWN	VERY SENSITIVE TO IMPACT, FRICTION, SPARKS. CORROSIVE TO COPPER, ZINC. VERY SLIGHTLY TOXIC.
LEAD STYPHNATE	LIGHT ORANGE TO REDDISH BROWN	SAME AS LEAD AZIDE.
MERCURY FULMINATE	GRAYISH	VERY SENSITIVE TO IMPACT, FRICTION, SPARKS. CORROSIVE TO ALUMINUM, MAGNESIUM, BRONZE, COPPER, ZINC, BRASS. HIGHLY TOXIC THROUGH SKIN ABSORPTION, INHALATION, INGESTION. SYMPTOMS RESEMBLE MERCURY POISONING.

PYROTECHNIC AGENTS USED AT MMR

SYMBOL	COMMON NAME	VISUAL IDENTIFICATION	ACTION
CS	NONE	WHITE CRYSTALLINE SOLID	TEAR AGENT
HC	HEXACHORO-ETHANE	WHITE SOLID	SCREENING SMOKE
WP	WHITE PHOSPHOROUS	PALE YELLOW SOLID	SCREEN SMOKE AND INCENDIARY
RP	RED PHOSPHOROUS	REDDISH BROWN POWDER	SCREENING SMOKE

OTHER COMPOUNDS

NAME	PROPERTIES	STABILITY
Picric Acid	lemon-yellow crystalline solid	very sensitive to blows or friction
Tetryl	fine yellow crystalline powder	sensitive to blows or friction
Composition A	unknown	unknown
Composition C3	unknown	unknown
Composition C4	unknown	unknown
Pentolite (50/50)	unknown	unknown
Tracer Compound	unknown	unknown
PBX	unknown	unknown
Ednatol	unknown	unknown
Tetrytol	unknown	unknown